A.21 LIVING WITH A STAR TARGETED RESEARCH AND TECHNOLOGY

Amended May 20, 2005
This final version of Appendix A.21: Living With a Star Targeted Research and Technology replaces in its entirety the Draft version that was released with the ROSES-2005 NASA Research Announcement. The due dates for Notices of Intent to propose (NOIs) and proposals given in Tables 2 and 3 of the ROSES-2005 *Summary of Solicitation* are unchanged.

1. Scope of Program

1.1 Overview

The goal of NASA's Living With a Star (LWS) program is to develop the scientific understanding needed for the United States to effectively address those aspects of the connected Sun Solar System that may affect life and society. The LWS Targeted Research and Technology (TR&T) program element solicits proposals leading to a physics-based understanding of the integral system linking the Sun to the Solar System both directly and via the heliosphere, planetary magnetospheres, and ionospheres. The TR&T program's objectives can be achieved by data analysis, theory, and modeling, and the development of tools and methods (e.g., software for data handling). LWS is a crosscutting initiative whose goals relate to many of NASA's exploration objectives, namely (and in no priority order):

- To understand and protect our home planet
  - *Dynamic Earth System* - LWS will provide understanding of the effects of solar variability on terrestrial climate change and of the causes of solar and magnetospheric disturbances on the Earth's technology infrastructures.
  - *Aerospace Technology* - LWS characterizes those aspects of the Earth's dynamic environment needed to design reliable electronic subsystems for use in air and space transportation systems.

- To explore the universe and search for life
  - *Human and robotic exploration of the Moon and Mars* - LWS will develop the knowledge needed to provide advance-warning space environment predictions along and at the path of robotic and human exploration.
  - *Robotic exploration of the Solar System* – LWS will quantify the physics, dynamics, and behavior of the Sun-heliophysical system over the 11-year solar cycle.

- To inspire the next generation of explorers
  - LWS will engage and motivate the public by supporting a lifetime of learning about the Sun and its effects on each element of the Solar System.

The *Final Report of the LWS TR&T Science Definition Team (SDT)* (December 2003), located on the LWS TR&T homepage at http://lws-trt.gsfc.nasa.gov/trt_resources.htm, identified particular scientific topics to be addressed using measurements by the LWS space flight missions, as well as data from other missions, and also by employing theory and modeling efforts. Among these topics are: the role of solar variability in climate and in stratospheric chemistry, ionospheric perturbations and scintillations, neutral thermosphere composition and density, geomagnetically-induced currents; energetic particles in the magnetosphere and atmosphere, and radiation associated with explosive events on the sun. The hazards to and effects on society, space-based systems, and human space flight are of particular importance to this program.

Significant progress toward quantitative understanding and predictive capability with respect to these problems will require large-scale, integrated modeling activities. Recognizing the need for activities that would be broader and more sustained than those that can be supported by a traditional NASA grants program, the TR&T Science Definition Team Report recommended that "*…large modeling activities that address coupling across traditional science domains in the Sun-Earth chain specifically be included as strategic capabilities.*" The TR&T SDT also recommended the formation of a TR&T Steering Committee in order to update periodically the designated strategic capabilities for future NRAs. The most recent report of this Steering Committee is available on the LWS TR&T homepage at the address given above.

As a result of these studies and recommendations, the LWS TR&T program has defined a strategy with three program elements, namely, Strategic Capabilities, Targeted Investigations, and Cross-Disciplinary Infrastructure Building programs. *This current solicitation requests proposals only for the last two of these program elements as discussed in the following subsections. A separate solicitation will be issued in 2005 at least 90 days prior to the proposal due date soliciting proposals on Strategic Capabilities.*

Further background material concerning relevant research objectives can be found in the following documents:

- The National Academy of Sciences Web tutorial, entitled "*Space Weather: A Research Perspective*" (http://www7.nationalacademies.org/ssb/SSB_Space_weather97.pdf);
- The Sun Earth Connection LWS web site (http://lws.gsfc.nasa.gov/);
- The LWS Science Architecture Team report to SECAS (http://lws.gsfc.nasa.gov/documents/sat/sat_report2.pdf;
- *The Sun-Earth Connection Roadmap Report* (http://sec.gsfc.nasa.gov/sec_2002_roadmap.pdf);
- *The Geospace Mission Definition Team Report* (http://lws.gsfc.nasa.gov/docs/documents/geospace/geospace_gmdt_report.pdf);
- *The NRC Decadal Survey Report* (http://www.nap.edu/books/0309089727/html/);
- *The TR&T Science Definition Team Report* (http://lws-trt.gsfc.nasa.gov/TRT_SDT_Report.pdf); and

- *The TR&T Steering Committee Team Report* http://lws-trt.gsfc.nasa.gov/trt_resources.htm).

1.2 Targeted Investigations

This Targeted Investigations program element is subdivided into the three components described below and, pending the submission of proposals of adequate merit, the approximate portion of resources allocated for each is given in parentheses.

1.2.1 Tools and Methods (10%)

The Tools and Methods component supports studies that, by themselves, may not deliver significant new science understanding, but instead deliver tools and/or methods that enable critically needed science advances. Examples include the development of new empirical methods or analysis techniques, such as local helioseismology, that can be used to forecast solar, interplanetary, and geospace activity, and the development of software tools that can identify, retrieve, assimilate, and/or portray data in order to model results from different sources for LWS research and forecasting objectives.

1.2.2 Independent Investigations (15%)

The Independent Investigations component supports studies that are not appropriate for either the Tools and Methods component above or the Focused Science Targets component discussed in the next section. However, simply failing to address these other two components does not necessarily make a project suitable for this Independent Investigations component. Rather, the criteria that determine whether a proposed study should be submitted to this component are its urgency and impact to LWS goals and objectives.

1.2.3. Focused Science Topics (75%)

The stated goal of LWS, that of achieving an understanding of those aspects of the Sun-Earth system that have direct impact on life and society, poses two great challenges for the TR&T program. First, the TR&T must tackle large-scale problems that cross discipline and technique (e.g., data analysis, theory, modeling, etc.) boundaries; and second, the TR&T must identify how this new understanding will have a direct impact on life and society. To address these requirements, a set of five Focused Science Topics as further identified below have been chosen for emphasis in this solicitation (for further detail, also see the TR&T Steering Committee Report at http://lws-trt.gsfc.nasa.gov/trt_resources.htm). Therefore, while the primary evaluation criteria remain unchanged (see this NRA's *Summary of Solicitation*, Section V(a), and the *NASA Guidebook for Proposers*, Appendix C.2), the criterion for relevance includes relevance to one of these five Focused Science Topics as an essential requirement for selection within this component. In addition, NASA desires a balance of research investigation techniques for each Topic, including theory, modeling, data analysis, observations, and simulations. Given the submission of proposals of adequate number and merit, up to eight selections will be made for each Focused Science Topic. Once selected, these investigators will form a team in order to coordinate their research programs (similar to the PIs selected for a NASA hardware mission who form a coordinated science working group). These teams will define a plan for structuring their work into an integrated research program that ideally will address the Focused Science Topic in a much more complete way than any one investigation could by itself. These teams will also define success measures and deliverables for their integrated program, develop strategies for disseminating their results to the science community and NASA, and prepare an integrated final Team Report at the end of the three-year duration of the selected investigations.

Based in part on the peer review, one of the PIs will be identified and asked to serve as the Team Coordinator for the Focused Science Topic for which he/she proposed. These Team Coordinators will take the lead role in organizing their teams, setting up appropriate meetings and interactions, and generally ensuring the success of the project as a whole. The Team Coordinators will also serve as the lead liaison with the TR&T Project Office at NASA's Goddard Space Flight Center (GSFC) and LWS Program Office at NASA Headquarters, which together will monitor and assist the progress of each team. The Team Coordinator will receive supplemental funding as necessary to support costs associated with these duties. Proposers are encouraged to propose to act as a Team Coordinator and if they do so, should include a brief section in their proposal describing how they would lead the team effort. Up to one extra page in the proposal is allowed for this proposed effort. All proposers for Focused Science Topics should include sufficient travel funds in their proposed budgets to cover two team meetings per year to be held on the U.S. coast furthest from their home institutions.

The Focused Science Topics appropriate as the objectives for proposals to this LWS TR&T solicitation are as follows:

<u>a. Shock acceleration of solar energetic particles by interplanetary CMEs</u>

Target description: Understanding large, gradual solar energetic particle (SEP) events is central to space weather and space climate. Gradual events observed at Earth are accelerated near the Sun and in the heliosphere by shocks associated with interplanetary CMEs (ICMEs). However, direct comparisons between observations, models, and theories have been scarce. It is now clear that in order to make progress in understanding the solar particle radiation environment near Earth, a cross-disciplinary approach is needed. It is necessary to combine studies of shock acceleration of energetic-particles, their propagation, and the evolution of CMEs in the heliosphere,

Goals and measures of success: The goal of this topic is to establish the spatial and temporal evolution of large geoeffective gradual SEP events throughout the heliosphere including acceleration of the SEPs at the CME-driven shock wave, SEP electron and ion composition, SEP propagation in the solar wind, wave excitation by SEPs upstream and downstream of the shock, and the resulting radiation environment in interplanetary space from Earth to Mars orbit.

Types of solicited investigations: Proposals are encouraged which contribute to our understanding of gradual SEP events using either observations or theoretical analysis. Numerical and analytical models are both relevant. Proposals are further encouraged to target fundamental features of these events including particle injection at the shock, the evolution of the CME-driven shock in the corona and solar wind, the formation of the upstream wave spectrum, particle diffusion, particle escape from the shock to Earth orbit, particle anisotropies, ion fractionation, the role of magnetic field obliquity, and the special behavior of gradual events close to the Sun or at long times and/or large heliocentric radii. Theoretical proposals should relate proposed analytical and numerical model results to observations.

<u>b. Determine the mechanisms that heat and accelerate the solar wind</u>

Target description: The solar wind creates the heliosphere, and determines our space environment from the low corona, past the planetary magnetospheres, to the solar wind termination shock and the boundary with interstellar space. In spite of its importance as the medium of the Sun-Earth connection, its origins as either "fast" or "slow" wind remain unclear. The heating of the ions perpendicular to the magnetic field and the preferential heating of the heavy ions are important clues to the origin of the fast wind, but specific heating/acceleration mechanisms have not yet identified.

Goals and measures of success: The goal of this topic is to combine theoretical studies, numerical simulations, and in situ or remote observations to understand how the fast and slow solar wind are heated and accelerated. The measure of success, and the criterion for proposal selection, is the potential impact of the work on our understanding of the solar wind, including both the fast and the slow wind, and a possible relation between them.

Types of solicited investigations: Proposals may be based on theoretical investigations of specific acceleration mechanisms, modeling the effects of specific mechanisms on the solar wind flow, or observations pertaining to the identification of the operative mechanisms. Acceleration mechanisms may include wave-particle interactions, turbulent heating, magnetic mirroring, and the consequences of magnetic reconnection at or above the coronal base (e.g. enhanced heating or reconnection-driven plasma jets). Models might include solar wind flows with specified physical heating mechanisms and appropriate magnetic field configurations. Relevant observations include ion and electron distribution functions, and their density, speed and temperature moments, ion composition, average magnetic field, magnetic field and plasma fluctuation spectra, and remote sensing of plasma properties in the corona.

<u>c. Solar wind plasma entry and transport in the magnetosphere</u>

Target description: Prolonged exposure to suprathermal magnetospheric plasmas has deleterious effects upon spacecraft. Examples include leakage, sputtering, and spacecraft surface charging. Determining the characteristics of the plasma population within the magnetosphere as a function of location, geomagnetic activity, solar wind conditions, and solar cycle is, therefore, a question of fundamental importance to spacecraft designers. Predicting the characteristics of the particle population requires knowledge of the locations and mechanisms by which solar wind plasma enters the magnetosphere, the processes by which plasma is energized and transported, and the interactions by which plasma is lost.

Goals and measures of success: The ultimate objective of this targeted research area is a global model for the solar wind-magnetosphere interaction capable of accurately predicting the plasma environment within the Earth's inner magnetosphere ($R < 10\ R_E$) as a function of prevailing solar wind conditions. Steps towards this goal include (1) development of empirical models for the geospace plasma as a function of solar wind conditions, geomagnetic activity, and solar cycle; (2) models that incorporate the fundamental physics describing plasma entry at the magnetopause and energization/transport within the magnetosphere models; (3) validation of the simulations against a variety of observational case studies and empirical models; and (4) development of a quantitative understanding of the relative roles of solar wind and ionospheric plasma sources in populating the magnetosphere.

Types of Solicited Investigations: Proposals that address this topic should address the mechanisms by which plasma crosses the magnetopause, the means by which plasma is energized and transported to the inner magnetospheric regions relevant to spacecraft operations, and the characteristics of the plasma within the magnetosphere. The research objectives of proposals include investigations that predict and quantify: (1) the amount of solar wind plasma entering the magnetosphere as a function of location on the magnetopause; (2) the processes by which plasma is transported from the magnetopause into the magnetosphere to form the plasma sheet; and (3) the mechanisms by which plasma is injected into the inner magnetosphere for different solar wind, geomagnetic, and solar cycle conditions.

d. Storm effects on the global electrodynamics and the middle and low latitude ionosphere

Target Description: Magnetic storms cause large departures of electric fields from their quiet values and large changes in the mid and low latitude ionosphere. The electric field perturbations cover a broad range of spatial and temporal scales and strongly affect plasmaspheric erosion and reconfiguration, ionospheric dynamics and plasma distribution, and the occurrence of ionospheric plasma instabilities which can severely disrupt communication and navigation systems over a large area of the Earth. Significant progress has been achieved in our understanding of mid and low latitude storm-time electrodynamics and their effects on the ionosphere by the use of TEC and global imaging, but there are fundamentally important unresolved questions dealing with their large spatial and temporal variability. A global understanding of this variability and of the processes involved is essential for realistic storm time ionospheric forecasting, which is increasingly important for a number of space based systems.

Goals and Measures of Success: The goal of this targeted research is to produce improved understanding and forecasting capabilities of storm electrodynamics from subauroral to equatorial latitudes and their effects on the ionosphere in response to different solar wind and magnetospheric conditions. The forecasting of these storm effects from numerical models will be validated against global electric field and ionospheric measurements, taking into account variations with longitude, season, and solar flux.

Types of Solicited Investigations: Proposals that address this topic are encouraged to consider storm electrodynamics from a global ionospheric-magnetospheric perspective. The research objectives of proposals will include modeling and empirical investigations that deal with (1) techniques to improve the specification and forecasting of magnetospheric parameters that play fundamental roles in middle and low latitude storm electrodynamics; (2) techniques that substantially enhance the database of global mid and low latitude electric field measurements; (3) the generation of mid-latitude polarization electric fields, their temporal and global spatial dependence, and their relationship to lower latitude storm electrodynamics; and (4) the storm time dependence and global distribution of prompt penetration electric fields from subauroral to equatorial latitudes under different solar, ionospheric, and magnetospheric conditions and their effects on the ionosphere.

<u>e. Determine the effects of changes in the atmospheric abundance of greenhouse gases on the temperature and dynamics of the upper atmosphere</u>

*Target description**:*** Of the three terrestrial planets, the Earth's upper atmosphere is unique in that it is characterized by a high-temperature thermosphere as compared to Venus and Mars whose upper atmospheres are cooler and described as cryospheres. The low density of triatomic molecules in the terrestrial upper thermosphere makes cooling to space inefficient and the major heat loss is downward transport to regions with higher densities of IR active molecules that can radiate the excess heat to space. This feature of our upper atmosphere means that even small increases in the abundance of these heat radiating molecules will provoke additional cooling of the upper atmosphere, with potentially dramatic effects on the neutral and ionized upper atmosphere. Any increase in anthropogenic greenhouse gases should lead to additional cooling of the thermosphere. The lack of feedback mechanisms makes the thermosphere and ionosphere an attractive laboratory to look for and study the effects of global greenhouse warming. A complicating factor is that the temperature and ionization in these layers are driven by variable factors such as UV and X-ray flux from the Sun and coupling from the lower atmosphere. Hence, anthropogenic effects must be separated from external effects due to solar forcing and coupling to the lower atmosphere.

Goals and measures of success: The underlying goal of this focused science target is to clarify the effects of greenhouse gases on the temperature and dynamics of the upper atmosphere, in order to improve our understanding of their effects on the atmosphere as a whole and their role in global climate change. One measure of success is a clearer understanding of the relative effects of solar forcing and radiative cooling at various altitudes in the upper atmosphere as a function of varying levels of solar forcing. A quantification of the expected impacts of anticipated increases in atmospheric greenhouse gases of anthropogenic origin would be another important and highly useful measure of success. Characterization of the effects of increased IR gases on the upper atmosphere in the context of predicted effects in the lower atmosphere and in comparison to conditions in the cryospheres of the other terrestrial planets is an additional goal.

Amended June 6, 2005
Begin insertion
Types of solicited investigations: Both theoretical and experimental investigations are encouraged. Modeling of the existing thermosphere in comparison to the upper atmospheres of the other planets and also in terms of its response to varying amounts of greenhouse gases would be an integral activity of this focus group. Analysis of existing data or new observations of the thermal structure, composition and density distribution of the thermosphere and ionosphere could be used to help establish the baseline structure of the upper atmosphere and to look for the effects of global greenhouse warming. These investigations would need to be performed in the context of coupling to the lower atmosphere and strong solar forcing that will require quantification of the flux of energetic radiation and atomic particles from the Sun and their variation in response to short-term impulsive events and to the slower changes in background radiation that occur over the course of the solar cycle.
End insertion

1.3 Cross-Discipline Infrastructure Building Programs

One of the major challenges facing the LWS program is the development of a research community that can cross traditional discipline boundaries and attack the system-wide problems that are central to understanding and modeling the Sun-Solar System connection. In order to address this challenge, proposals to this LWS TR&T program may include one or more of these infrastructure-building elements: cross-disciplinary workshops, summer schools, and/or postdoctoral programs. Most of these activities will be supported through formal proposals to the TR&T as part of the regular proposal cycle. In all cases, an extra two pages will be allowed to the page limit for the

Science/Technical/Management section of the proposal (see the *NASA Guidebook for Proposers* discussed below) for each of these activities.

a. Support of LWS Workshops/Campaigns: Given the goals of the Infrastructure Building Program, there are several guidelines that successful requests for *workshop/campaign* support must satisfy:

1. The workshop must address a science or technology topic that is both timely and important to the goals of LWS.
2. The workshop topic must be cross-disciplinary in nature and bring together researchers from different disciplines in LWS science.
3. Although there are no restrictions as to where the workshop will be held, it will clearly be advantageous to hold it at a location that is convenient and cost-effective for LWS researchers and students.
4. Workshops that encourage the training of new researchers in LWS system science are strongly encouraged.
5. Workshops that leverage funding from other institutions and agencies are strongly encouraged.

b. Support of LWS Summer Schools for Graduate Students: The details of the summer school (e.g., format, location, duration, etc.) are left to the proposer to define. However, proposals should provide convincing evidence concerning the breadth of the topics to be considered, the means to be taken to assure participation by recognized research/education authorities, and any institutional support that may be forthcoming (note: shared support of this activity is strongly encouraged). One such proposal may be selected for Summer School activities not to exceed more than two years during the nominal three-year period of performance for the parent research proposal.

c. Support of Postdoctoral Research Associates. Research proposals may propose to support up to two LWS postdoctoral associates who either expect to receive their doctor's degree within one year from the nominal beginning of the period of performance of the parent research award, or have received their degrees within the past two years of that date. The research work carried out must be of a cross-disciplinary nature that satisfies LWS goals. Such associates may be supported for two years, with the possibility of a subsequent merit-based extension not to extend beyond the full period of performance of the parent research award. In addition to salary, the terms of the award may include relocation, travel, and research expenses commensurate with contemporary standards. If a suitable candidate is known at the time the proposal is submitted, an additional two pages is allowed in the parent proposal that describes the proposed research to be carried out by the associate, including its relevance to LWS program.

2. Programmatic Information

2.1 Demonstration of Relevance to LWS Objectives

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (see below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes the following factor:

- Proposals will be evaluated on the basis of their feasibility, intrinsic scientific merit, and compliance with requirements to provide public access to any tools and value-added products developed. Proposals should provide a detailed (~1/2 page) description of how the proposed work will benefit the goals and objectives of the LWS program described above, and the timetable over which these benefits will accrue. To this end, the LWS program will provide a web site (http://lwstrt.gsfc.nasa.gov/trt_proposals.htm) that provides links to the abstracts of all selected proposals and their annual progress reports, including developed and tested software and/or refined data products.

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "relevance to NASA's strategic goals and objectives" specifically includes the following factor:

- The degree to which the proposed investigation is relevant to one of the five Focused Science Topics described in Section 1.2.3.

To aid in the identification of reviewers, it is essential that the electronically submitted *Cover Page* for LWS TR&T proposals (see further below) include a single choice of program descriptor (i.e., T for Targeted Research or C for Cross Discipline Infrastructure) and the relevant program objective under each descriptor as follows:

- T1 -- Tools and Methods,
- T2 -- Independent Investigations,
- T3a -- Shock Acceleration of Solar Energetic Particles,
- T3b -- Determine the mechanisms that heat and accelerate the solar wind,
- T3c -- Solar Wind Plasma Transport and Entry,
- T3d -- Storm effects on the global electrodynamics and TEC, or
- T3e -- Determine the effects of changes in the atmospheric abundance of greenhouse gases.

In addition, each proposal may additionally include one or more of the following descriptors as appropriate:

- C1 -- Workshop/Campaign,
- C2 -- Summer School, and/or
- C3 -- Post Doctorate Associates.

Therefore, a proposal for Shock Acceleration of Solar Energetic Particles that includes provisions for both a Summer School as well as a Postdoctorate Associate would be labeled "T3a-C2-C3".

2.2. Demonstration of Relevance to NASA Objectives

Proposals for all of NASA sponsored research programs are judged on three criteria: Scientific and technical merit of the proposed work, cost realism and reasonableness, and relevance of the proposed work to NASA missions and science goals (see also Appendix C of the *Guidebook for Proposers Responding to NASA Research Announcement – 2005* at http://www.hq.nasa.gov/office/procurement/nraguidebook/). To enable the NASA Science Mission Directorate to properly evaluate the relevance of proposals submitted to its programs, as well as track its progress toward achieving its goals as mandated by the Government Performance Review Act (GPRA), it is mandatory that all research supported by NASA's programs demonstrate its relationship to NASA strategic goals and/or science objectives as stated in the latest version of its Strategic Plan; see the discussion in Section I(a) of the *Summary of Solicitation* of this NRA. Therefore, in addition to addressing the specific goals of this program, all proposers must provide as expository text in the main body of their proposal a statement of the relevance of their proposed work to NASA's *Strategic Objectives* given in Table 1 in the *Summary of Solicitation* of this NRA. This discussion need not exceed the order of a quarter page of text and is to be included in the introduction to the Science-Technical-Management section of proposal.

Note that this NRA references NASA's 2005 strategic objectives (see Section I(a) and Table 1 for references).

2.3 Summary of Key Information

Expected total program budget for new awards	~ $5M
Number of new awards pending adequate proposals of merit	~ 40
Maximum duration of awards	3 years; shorter term proposals are encouraged.
Page length for the central Science-Technical-Management section of proposal	15 pp (but see Section 1.3 for exceptions); see also Chapter 2 of *Guidebook for Proposers Responding to NASA Research Announcement – 2005*

Submission medium and number of copies	Hard copy only (15 copies plus signed original); see also Chapter 3 of *Guidebook for Proposers Responding to NASA Research Announcement – 2005*
NASA Strategic Objectives to which proposals to this program <u>must</u> state and demonstrate relevance	See Table 1 in the *Summary of Solicitation* of this NRA.
General information and overview of this solicitation	See *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	*Guidebook for Proposers Responding to NASA Research Announcement – 2005* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Web site for submission of proposal Cover Page:	URL: http://nspires.nasaprs.com (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Due Date for Notice of Intent to Propose	See Tables 2 or 3 in *Summary of Solicitation* of this NRA.
Due Date for delivery of proposals	See Tables 2 or 3 in *Summary of Solicitation* of this NRA.
Address for the delivery of proposals	Living with a Star Targeted Research and Technology ROSES-2005 NRA Science Mission Directorate NASA Peer Review Services Suite 200 500 E Street, SW Washington, DC 20024 Telephone: (202) 479-9030
Point of contact concerning this program	Dr. Madhulika Guhathakurta Earth-Sun System Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1992 E-mail: Madhulika.Guhathakurta@nasa.gov